(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4301 Roll No. | | | | | | | | | | |

B. Tech.

(Semester-I) Theory Examination, 2011-12

ENGINEERING MECHANICS

Time : 3 Hours] *[Total Marks : 100*

Note : (i) This paper is in three Sections. Section-A carries 20 marks, Section-B carries 30 marks and Section-C carries 50 marks.

(ii) Attempt *all* questions. Marks are indicated against each question part.

(iii) Assume missing data suitably, if any.

Section-A

1. You are required to answer briefly *all* the following parts : 2×10=20

(a) Define the law of parallelogram law of forces. What is the use of this law?

(b) Explain the difference between coefficient of friction and angle of friction.

(c) What are the assumptions made in the analysis of a simple truss?

(d) What do you mean by the point of contraflexure? Is the point of contraflexure and point of inflexion different?

(e) State the theorem of perpendicular axis.

(f) Define centre of gravity and centroid.

(g) Distinguish between relative velocity and resultant velocity.

(h) Explain the various forms of mechanical energies.

(i) What do you mean by sagging and hogging moments? What kinds of curvatures are produced by them?

(j) What is pure torsion? Explain the difference between torsional stiffness and torsional rigidity.

Section-B

2. Answer any *three* parts of the following : 10×3=30

(a) A 750 N crate rests on a 500 N cart as shown in Fig. 1. The coefficient of friction between crate and cart is 0.3 and between the cart and the road is 0.2. If the cart is pulled by a force P such that the crate does not slip, determine :

(i) the maximum allowable magnitude of force P, and

(ii) the acceleration of cart.

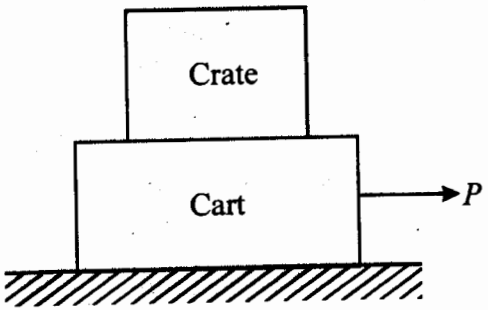

Fig. 1

(b) Calculate the values of shear force and bending moments for the cantilever beam shown in Fig. 2. Also draw the shear force and bending moment diagrams.

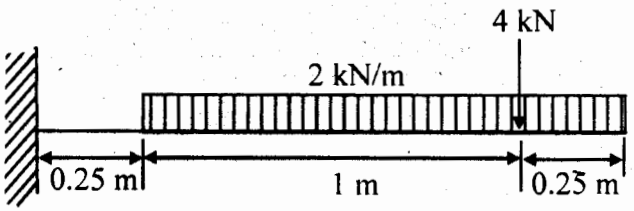

Fig. 2

(c) Calculate the moment of inertia of the hatched section shown in Fig. 3 about the centroidal XX axis.

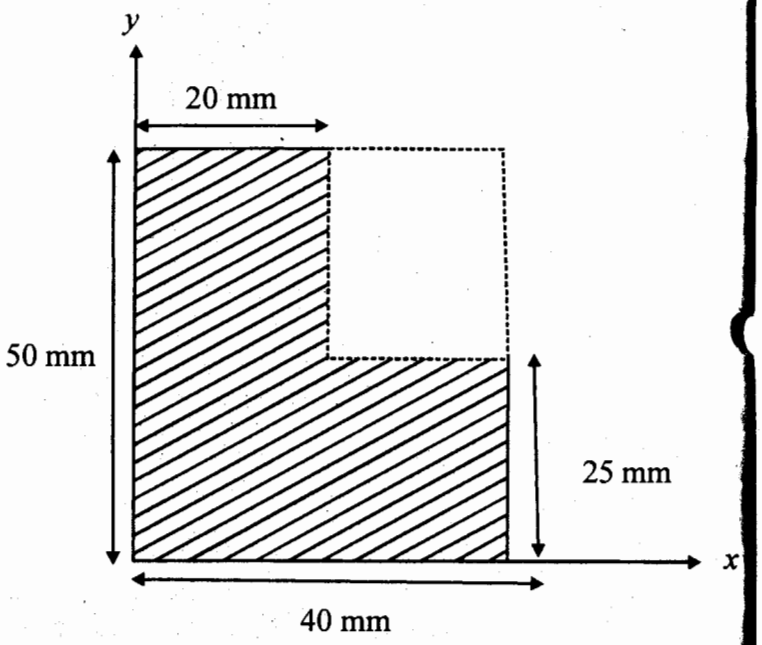

Fig. 3

(d) A 20 kg. slender rod shown in Fig. 4 is rotating in a vertical plane and at the instant shown, it has an angular velocity of 5 rad/sec.

Determine the rod's angular acceleration and the horizontal and vertical components of reactions at the pin at this instant.

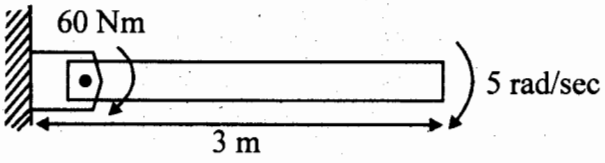

Fig. 4

(e) Calculate the maximum stress induced in a cast iron pipe of external diameter 40 cm and internal diameter 20 cm and of length

4 m when the pipe is supported at its ends and carries a point load of 80 N at its centre.

Section-C

3. Answer any *two* parts of the following : 5×2=10

(a) Explain the following :

(i) Classification of two-dimensional force system

(ii) Laws of coulomb friction.

(b) Derive an expression for the ratio of belt tensions.

(c) A man climbs on a 5 m long ladder. The ladder makes an angle of 60° from the

horizontal. The other end of the ladder is supported on a vertical wall. The coefficient of friction between the ladder and wall is 0.2 and between the ladder and floor is 0.3. The weights of ladder and man are 150 N and 800 N, respectively. How far can the man climb on the ladder?

4. Answer any *one* part of the following : 10×1=10

(a) Determine the forces and their nature in each member of truss loaded as shown in Fig. 5.

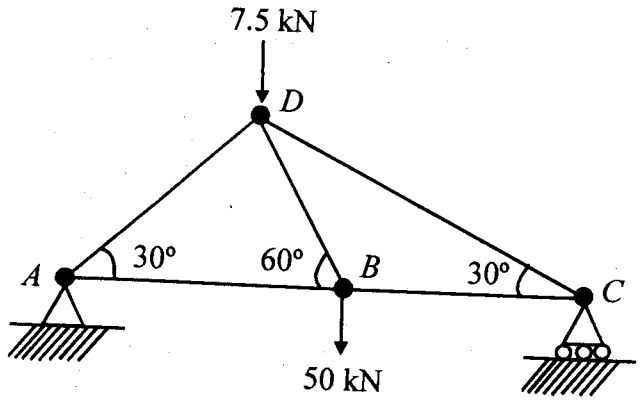

Fig. 5

(b) Draw the shear force and bending moment diagrams for the simple supported beam as shown in Fig. 6.

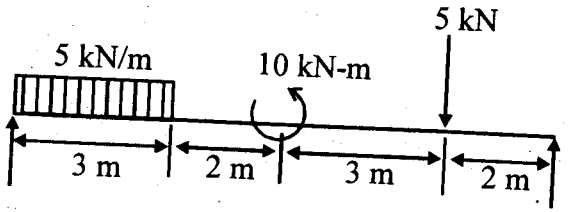

Fig. 6

5. Answer any *one* part of the following : $10 \times 1 = 10$

(a) (i) State and prove the theorems of parallel and perpendicular axis.

(ii) Derive an expression for the mass moment of inertia of a right circular cone about its axis.

(b) Determine the moment of intertia of T section about the horizontal and vertical axes, passing through the C.G. of the section as shown in Fig. 7.

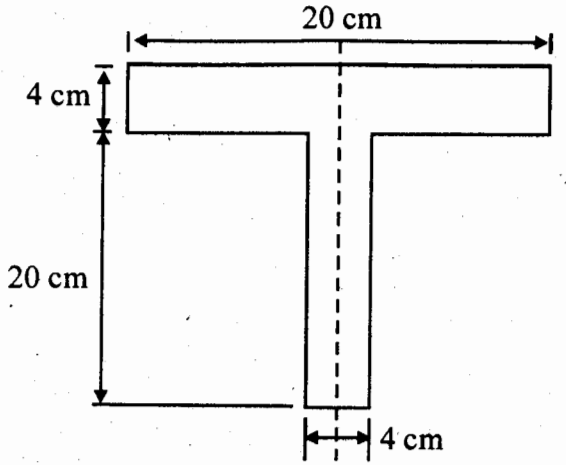

Fig. 7

6. Answer any *one* part of the following : 10×1=10

(a) (i) What do you mean by instantaneous centre of rotation? How can it be located for a body moving with combined motion of rotation and translation?

(ii) A wheel rotating about a fixed axis at 20 rpm is uniformly accelerated for 70 sec. during which it makes 50 revolutions. Find angular velocity at the end of this interval and time required for speed to reach 100 rpm.

(b) A cord is wrapped around a wheel of radius 0.2 m, which is initially at rest as shown in Fig. 8. If a force is applied to the cord and gives it an acceleration $a = (4t)\,\mathrm{m/sec^2}$, where t is in second. Determine the angular velocity of the wheel and the angular position of line OP both as a function of time.

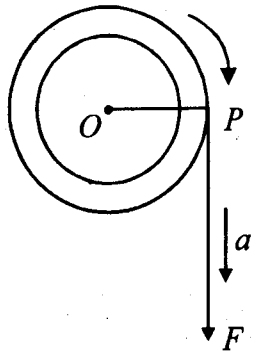

Fig. 8

7. Answer any *one* part of the following : 10×1=10

(a) What do you understand by the term neutral axis and neutral surface?.

A steel beam of hollow square section of 60 mm outer side and 50 mm inner side is simply supported on a span of 4 meters. Find the maximum concentrated load the beam can carry at the middle of the span if the bending stress is not to exceed 120 N/mm^2.

(b) State the assumptions made in the theory of pure torsion. Derive the torsion formula :

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}.$$